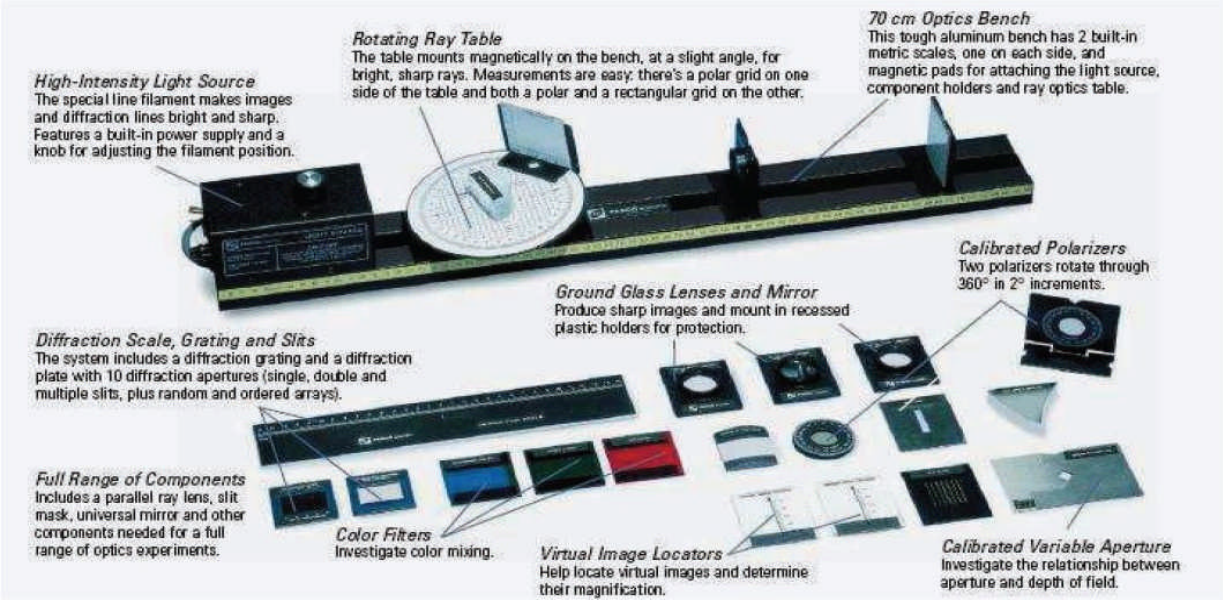
Optique

SYSTEME OPTIQUE D'INTRODUCTION
(Introductory Optic System)

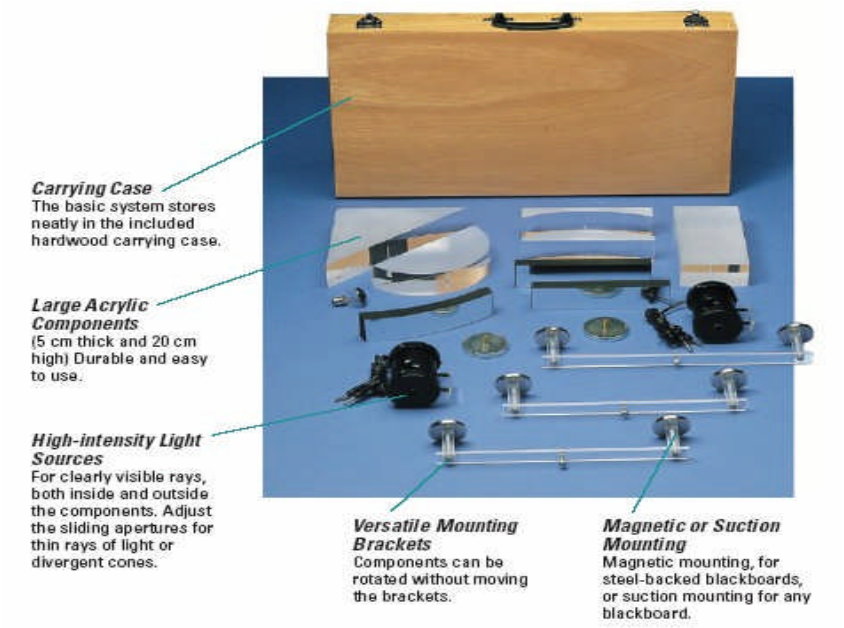

Rotating Ray Table
The table mounts magnetically on the bench, at a slight angle, for bright, sharp rays. Measurements are easy: there's a polar grid on one side of the table and both a polar and a rectangular grid on the other.
70 cm Optics Bench
This tough aluminum bench has 2 built-in metric scales, one on each side, and magnetic pads for attaching the light source, component holders and ray optics table.
High-Intensity Light Source
The special line filament makes images and diffraction lines bright and sharp. Features a built-in power supply and a knob for adjusting the filament position.
Calibrated Polarizers
Two polarizers rotate through 360° in 2° increments.
Ground Glass Lenses and Mirror
Produce sharp images and mount in recessed plastic holders for protection.
Diffraction Scale, Grating and Slits
The system includes a diffraction grating and a diffraction plate with 10 diffraction apertures (single, double and multiple slits, plus random and ordered arrays).
Full Range of Components
Includes a parallel ray lens, slit mask, universal mirror and other components needed for a full range of optics experiments.
Color Filters
Investigate color mixing.
Virtual Image Locators
Help locate virtual images and determine their magnification.
Calibrated Variable Aperture
Investigate the relationship between aperture and depth of field.

- **A Complete and Comprehensive System**
- **22 Experiments From Basic Ray Optics to Multiple-Slit Diffraction**
- **Easy Setup– Magnetic Mounting**

- **Système Complet et Educatif.**
- **22 expériences - De Ray Optiques De base à la Diffraction Multi Fente.**
- **Simple Installation.**

Typical Experiment:	***Expériences Typiques:***
1. Introduction to Ray Optics	1. Introduction au Ray Optique
2. The Law of Reflection	2. Loi de Réflexion
3. Image Formation in a Plane Mirror	3. formation D'image dans un Plan de Miroir
4. The Law of Refraction	4. Loi de Réfraction
5. Optical Reversibility	5. Réversibilité Optique
6. Dispersion and Total Internal Reflection	6. Dispersion et Réflexion interne Total.
7. Converging Lens—Image and Object Relationships	7. La Relation entre Lentille Convergeant -Image et Objet
8. Light and Color	8. Lumière et Couleur.
9. Two-slit Interference	9. Interférence Par deux Fentes.
10. Polarization	10. Polarisation.
11. Image Formation: Concave Mirrors	11. Formation D'image : Miroir Concave.
12. Image Formation: Spherical Mirrors	12. Formation D'image : Miroir Sphérique.
13. Image Formation: Cylindrical Lenses	13. Formation D'image : Lentilles Cylindrique.
14. Spherical Lenses: Spherical and Chromatic Aberration, Aperture Size, Depth of Field	14. Lentilles Sphérique : Aberration sphérique et Chromatique, Dimension de l'Ouverture, Profondeur de Champ.
15. The Diffraction Grating	15. La Grille de Diffraction
16. Single-slit Diffraction	16. Diffraction Par Une Fente.
17. General Diffraction	17. Diffraction Générale.
18. Introduction to Optical Instruments	18. Introduction au Instrument D'optique.
19. The Projector	19. Projecteur.
20. The Magnifier	20. The Magnifier
21. The Telescope	21. Telescope
22. The Compound Microscope	22. Composition Du Microscope.

SYSTEME OPTIQUE


Carrying Case
The basic system stores neatly in the included hardwood carrying case.
Large Acrylic Components
(5 cm thick and 20 cm high) Durable and easy to use.
High-intensity Light Sources
For clearly visible rays, both inside and outside the components. Adjust the sliding apertures for thin rays of light or divergent cones.
Versatile Mounting Brackets
Components can be rotated without moving the brackets.
Magnetic or Suction Mounting
Magnetic mounting, for steel-backed blackboards, or suction mounting for any blackboard.

Demonstrations:

Basic System primary demonstrations:

Reflection:

- *Law of Reflection*
- *Virtual Images*
- *Focal Lengths*
- *Real Images*

Refraction:

- *Law of Refraction*
- *Rectangular Block*
- *Critical Angle*
- *Total Internal Reflection*
- *Reversing Prism*
- *Angle of Minimum Deviation*

Lenses:

- *Focal Lengths*
- *Virtual Images*
- *Thick Lens Optics*

Basic System with Accessories additional demonstratıons:

Advanced

- *Focal Lengths: Double Convex and Double Concave Lens*
- *Real Image Formation:*
- *Double Convex Lens*
- *Nearsighted/Farsighted*
- *The Telescope*
- *The Microscope*
- *Spherical Aberration*
- *Dispersion: Prisms and Gratings*

2 Slit Interference

With this unique system, optics diagrams are transformed into working demonstrations. All components and light sources mount right on the blackboard. Instead of ray diagrams, students observe the interactions of actual light rays.

Systems Available:

The Basic Blackboard Optics Systems include:

- Ray projector (2)
- Holder for projector (2)
- Clamping bar, 13-inch (2)
- Clamping bar, 15-inch (1)
- Plano-convex lens (1)
- Plano-concave lens (1)
- Semicircular lens (1)
- Rectangular block (1)
- Prism, right angle (1)
- Plane mirror (2)
- Curved mirror, double (1)
- Projector lamp, spare (1)
- Cushioned storage cabinet (1)

Required: (for Blackboard Optics)

AC Transformer (110V version only)

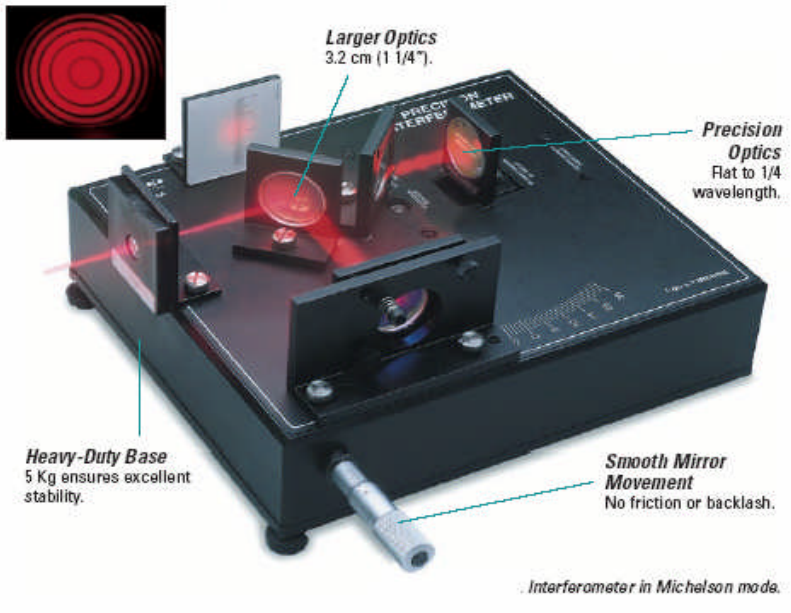
Or:

Equivalent supply providing up to 100 watts at 12 VAC

INTERFEROMETRE DE PRECISION
(Precision Interferometer)

- **Three Modes: Michelson, Fabry-Perot, Twyman-Green**
- **Large Precision Optics**
- **5 Kg Machined Aluminum Base**

- **Trois Mode : Michelson, Fabry-Perot, Twyman-Green**
- **Grande Précision Optique.**
- **Base D'aluminium de 5 Kg**



Interferometer in Michelson mode.

Typical Experiment

1. Introduction to Interferometry
2. The Index of Refraction of Air
3. The Index of Refraction of Glass

Experiences Typique

1. Introduction à L'interférométrie
2. L'indice De Réfraction De L'air
3. L'indice de Réfraction de Verre

No study of interferometry should overlook the historical importance of the Michelson interferometer. Yet in the laboratory, the Fabry-Perot and Twyman-Green interferometers can be more important tools; the first for high-resolution spectroscopy, the second for testing and producing optical components with aberrations that can be measured in fractions of a wavelength. The Interferometer is a high-precision, movable-mirror interferometer that can be used to perform Michelson, Fabry-Perot and Twyman-Green interferometry. Mirrors are attached with thumbscrews, so it's easy to set up and change configurations. The Interferometer can be ordered in a variety of systems. The Basic Interferometer can be operated in either the Michelson or Fabry-Perot modes. The Complete Interferometer Systems also contain components for the Twyman-Green mode and a vacuum pump for the refractive index of air experiment. The Systems Component List shows the contents of each system.

Features:

- **Stable:** The massive (5 kg) base is machined from a single block of aluminum ensuring extremely stable optics.
- **Smooth Mirror Movement:** With the taut-band suspension system, there's no starting or stopping friction and virtually no backlash (less than 0.5 micron).
- **Precise Measurements:** Mirror control is extremely fine one micron per division of the micrometer head. The mirrors and beam-splitter are flat to 1/4 wavelength to ensure uniform interference patterns.
- **Larger Optics:** The 3.2 cm (1 1/4") diameter optics in the PASCO Interferometer produce larger and sharper interference patterns for better experimental results.
- **Complete:** The Basic Interferometer includes everything necessary to perform basic Michelson and Fabry-Perot interferometry.

The Refractive Index of Air: slow evacuation of the gas cell shows the dependence of the refractive index on the air density.

SPECTROMETRE (Spectrometer)

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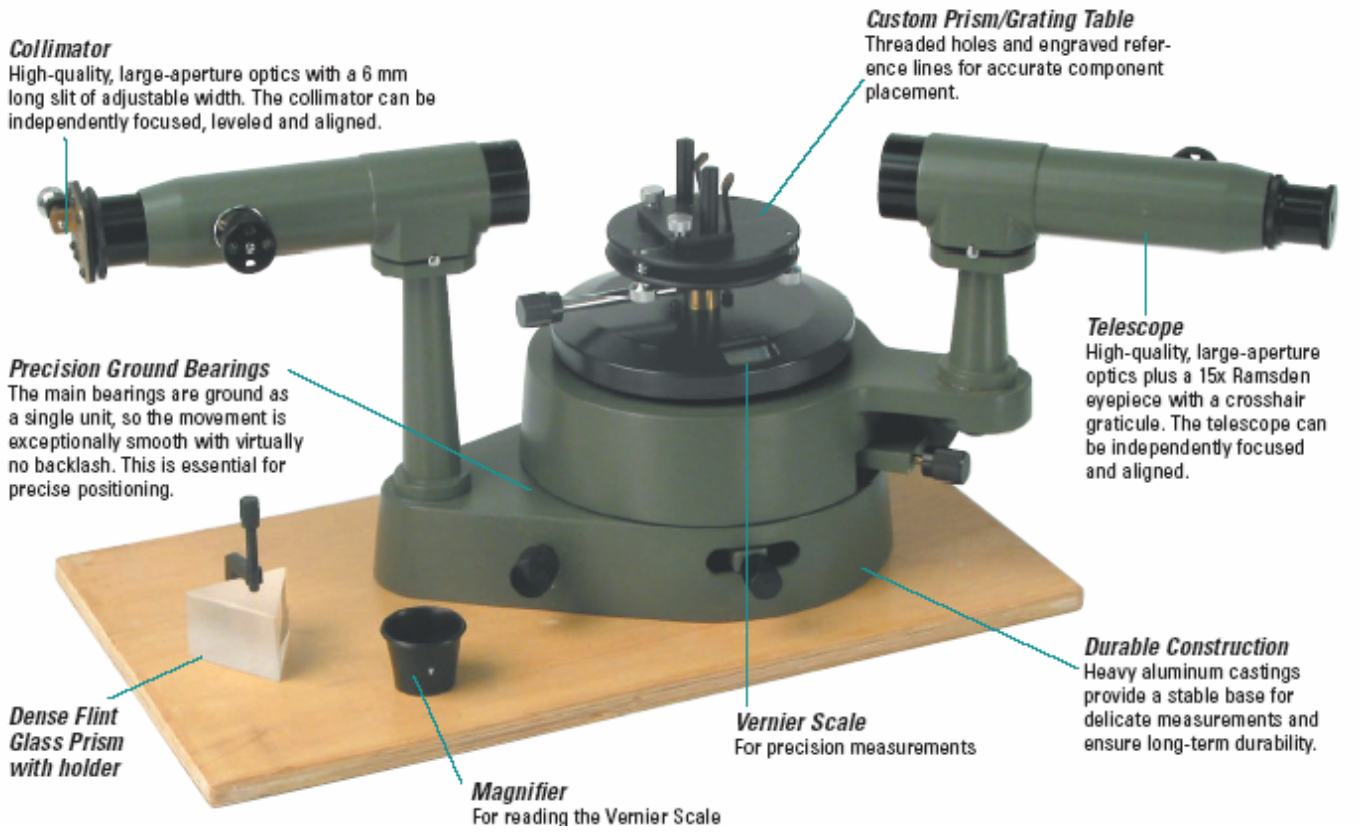

Collimator
High-quality, large-aperture optics with a 6 mm long slit of adjustable width. The collimator can be independently focused, leveled and aligned.
Custom Prism/Grating Table
Threaded holes and engraved reference lines for accurate component placement.
Telescope
High-quality, large-aperture optics plus a 15x Ramsden eyepiece with a crosshair graticule. The telescope can be independently focused and aligned.
Precision Ground Bearings
The main bearings are ground as a single unit, so the movement is exceptionally smooth with virtually no backlash. This is essential for precise positioning.
Durable Construction
Heavy aluminum castings provide a stable base for delicate measurements and ensure long-term durability.
Dense Flint Glass Prism with holder
Vernier Scale
For precision measurements
Magnifier
For reading the Vernier Scale

- **Wide Aperture Optics**
- **Precision Vernier— Resolves 1 Minute of Arc**
- **Durable and Precise**

- **Ouverture Optique Large**
- **Précision de Vernier – Résolution de 1Minute De L'Arc**
- **Solide et Précis**

Chemists use it to determine the constituents of molecules, astronomers use it to determine the constituents of stars and physicists use it to investigate the structure of the atom not bad for an instrument for which few people can name the inventor (David Alter, with some important later enhancements by Joseph von Fraunhofer).
We offer a choice of 2 high-quality spectrometers that allow students to perform accurate prism and grating spectrometry. High-quality, large-aperture optics produce sharp spectral images, while precision machining allows for precise rotation and accurate measurement.
The Student Spectrometer is most popular in upper division labs, where precision and durability are equally important.

Features:

- **Resolution to 1 Minute of Arc:** The 127 mm diameter, precision-engraved degree plate is complemented by 2 precision-engraved verniers, one on each side of the instrument for convenient reading.
- **Wider Aperture Optics:** 32 mm wide apertures on the telescope and collimator provide more light for brighter and sharper images.
- **Rack and Pinion Focusing:** On both the telescope and the collimator. Focusing is easier and more precise.
- **Rotatable Table:** For greater flexibility in measurements. Turn the table by hand for coarse adjustments. Use the fine lead screw for delicate adjustments.

Recommended:

Spectral Light Sources

SPECTROMETRE 3215.30
(Spectrometer)

This instrument is used for quantitative light experiments where refraction and diffraction of light is investigated.
The instrument is provided with an easy to read vernier scale that can be read directly in tenths of a degree.
The spectrometer is supplied with a prism and grating holder and an adjustable prism table.
The collimator and telescope are fitted with 178 mm focal length 32 mm aperture acromatic objectives. The telescope is fitted
with a 15x Ramsden eyepiece and crosshair reticle collimator with an adjustable slit.
The telescope and collimator are supported rigidly and in perfect alignment. The telescope and collimator mounting arrangement permits accurate leveling of the axes and squaring to the axis of rotation.
The support pillars for the telescope and collimator are made of solid metal blocks to provide durability and an enhanced streamlined appearance.
The spectrometer table, diameter 85 mm, is marked with lines to assist positioning of the prism in relation to the leveling screw, and it has interchangeable clamping units for prism and diffraction gratings.
All essential parts are interchangeable.

Spectral Lamp Housing:
Spectral Lamp Housing
Spectral Lamps
Ballast Transformer
Optical Grating
Flint Glass Prism

SPECTROGONIOMETRE DE PRECISION

Pour déterminer avec précision les données optiques des prismes. Peut également servir de spectroscope
pour observer et mesurer les spectres d'émission et d'absorption. Nombreux accessoires.

Tube d'observation :

- Réglable en continu
- Oculaire réticulaire
- Objectif : 18 mm / 160 mm
- Tube à fente:
- Fente symétrique de précision acier durci Oculaire
- Ouverture 18 mm, focale 160 mm

Prisme:

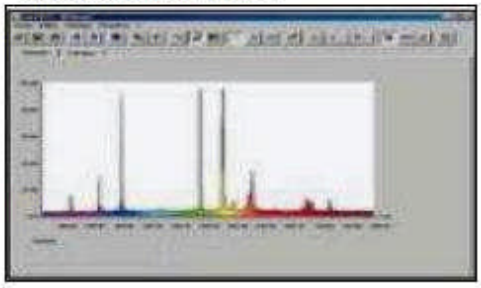
- Flint (60°)
- Dispersion: C-F 2°
- Longueur de base 33 mm, hauteur 22mm
- Graduation angulaire :0° à 360° pas de 0,5°
- Précision de lecture du vernier: 1 minute d'angle
  Masse: 7,9 kg

SPECTROPHOTOMETRE

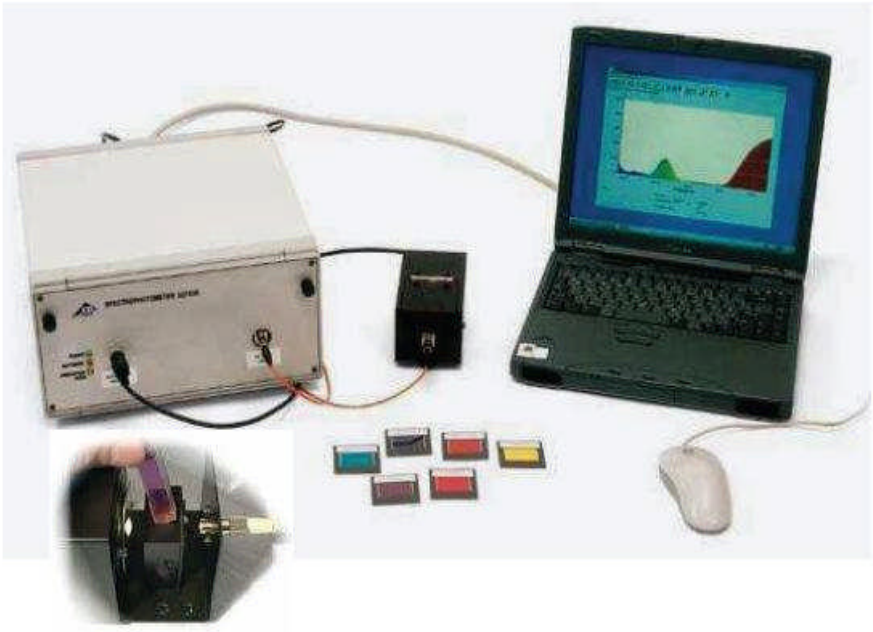
Conçu pour :

- L'étude quantitative des spectres d'émission et d'absorption
- L'étude quantitative des courbes de transmission
- Faire des mesures de colorimétrie et de cinétique chimique
- Une analyse en temps réel du spectre complet : gamme de longueur d'onde entre 370 et 830mm

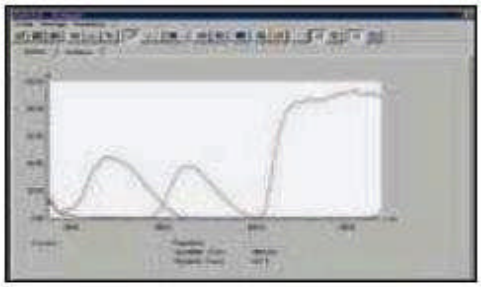
Spectre d'émission



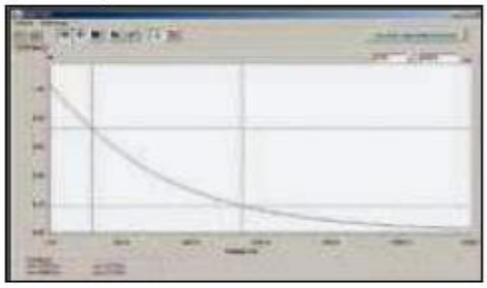
Spectre d'émission



Spectre de transmission



Cinétique



Principe :

La fente d'entrée du spectromètre est l'extrémité d'une fibre optique. L'autre extrémité collecte la lumière à analyser. Très souple et directive,
vous allez aisément faire en moins d'une seconde tout type de spectres sur votre ordinateur.

L'ensemble comprend :

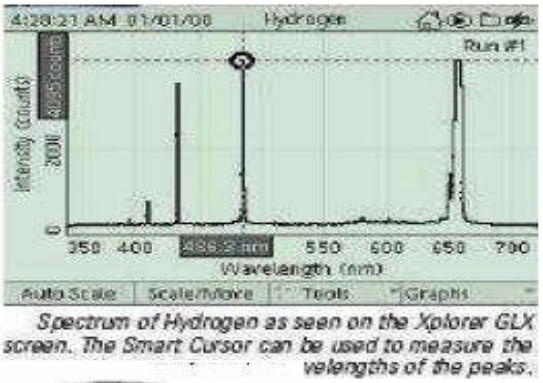
- 1 spectrophotomètre
- 1 module d'absorption avec porte-cuvette et porte-diapos pour cuvettes
à usage unique, ainsi que filtres couleur
- 1 CD du logiciel
- 1 guide d'onde, 1 m
- 1 câble raccord PC (USB)
- 1 câble DIN pour le raccord du module d'absorption
- 1 câble secteur
- 100 cuvettes à usage unique
- 1 manuel d'utilisation

Principales caractéristiques :

Logiciel SPID-HR complet compatible Windows
Câbles et accessoires fournis
Port USB
Module d'absorption
Plage spectrale : 370 – 830 nm
Résolution moyenne : 1 nm*
Transmission : de 0 à 100%, résolution 0,1%
Absorption : de 0 à 2A (0 à 100%)
Disposition optique : Czerny Turner
Détecteur CCD : 2 048 pixels
Lampe halogène au quartz : 2 V / 20 W
Connexion électrique : par guide d'onde
Tension secteur : 115 V / 230 V, 50/60 Hz
Dimensions : 315x175x322 mm
Masse : 6,6 kg

SPECTROMETER

Emission Spectrometer



Spectrum of Hydrogen as seen on the Xplorer GLX screen. The Smart Cursor can be used to measure the wavelengths of the peaks.

Uses Ocean Optics Red Tide Spectrometer:

In this Spectrometer System, the Xplorer GLX controls the Ocean Optics Red Tide Spectrometer which detects the spectrum through a fiber optics cable using a 2048 pixel CCD linear array. The Xplorer GLX can display 2048 wavelengths in less than 1 second as intensity, absorbance, transmittance, or relative irradiance.

Specifications:

Range: VIS-NIR, 380-950 nm
Resolution: 1 nm
Signal-to-Noise: 250:1 at full signal RMS
Dark Noise: 2.5 to 4

Includes:

Ocean Optics Red Tide Spectrometer
Fiber Optics Cable
USB Cable
License key for Ocean Optics GLX feature set

Required:

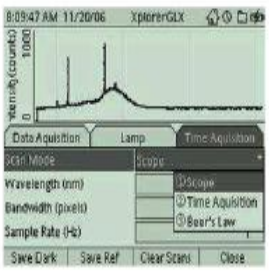
Xplorer GLX

Light from a Hydrogen tube is sampled using the fiber optics cable connected to the Ocean Optics Spectrometer. The Spectrometer is plugged into the USB port on the Xplorer GLX. (Light source not included)

Absorption Spectrometer

Full-scan spectroscopy without a computer:

The Ocean Optics Red Tide Spectrometer offers 1 nm Resolution over the range of 350-1000nm.
Full scan spectral data can be viewed in real-time on the Xplorer GLX with the integrated light source and cuvette holder. Choose single wavelengths for Beer's Law studies or scan a single wavelength versus time for kinetic studies. The Ocean Optics Red Tide and the Xplorer GLX with Light Source and Cuvette are a perfect fit for chemistry labs or field studies.



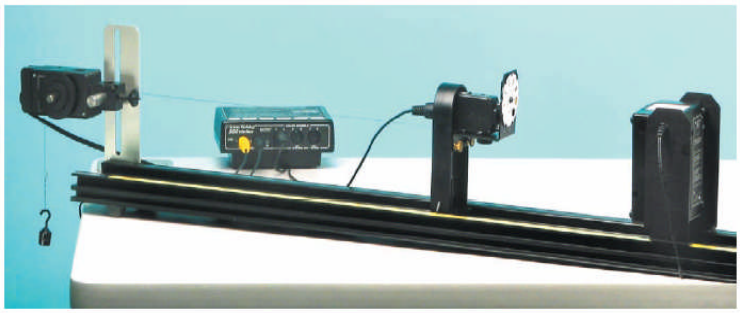
Includes:

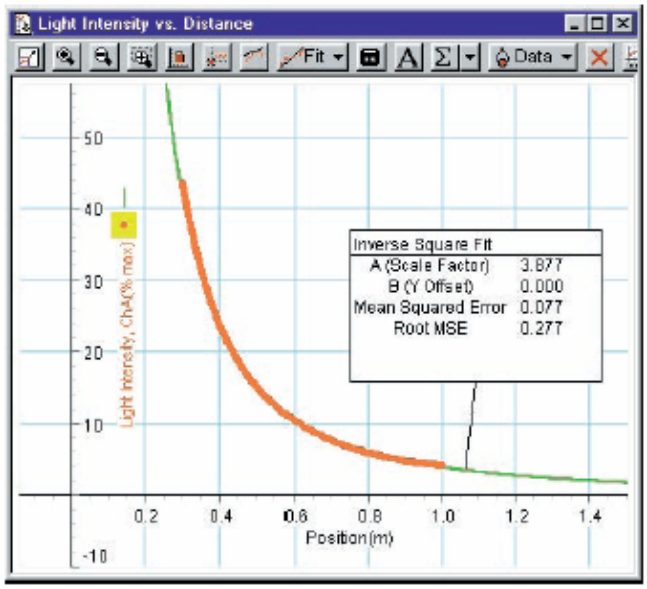
Ocean Optics Red Tide Spectrometer
Light Source and Cuvette Holder
USB Cable
License key for Ocean Optics GLX feature set

Required:

Xplorer GLX PS-2002

LOI INVERSE DE LA LUMIERE
(Inverse Square Law For Light)





- **The Intensity of Light Versus Distance from a Point Light Source**

- **L'Intensité De La Lumière En Fonction Du Point De La Source Lumineuse**

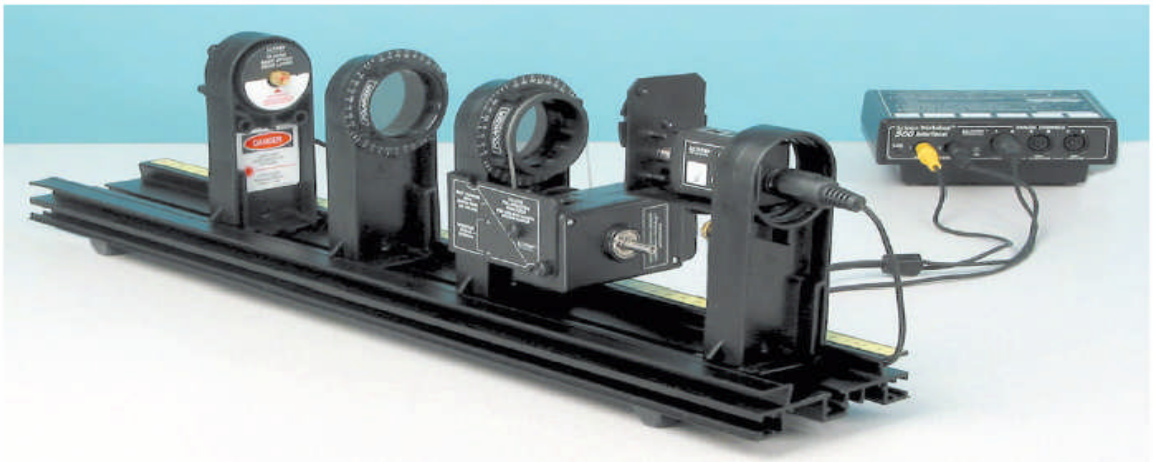
The dependence of the light intensity of a point light source on distance from the source is determined in this experiment. The relative light intensity versus distance from a point light source is plotted. As the Light Sensor is moved by hand, the string attached to the Light Sensor that passes over the Rotary Motion Sensor pulley to a hanging mass causes the pulley to rotate, measuring the position.
Using DataStudio, various curves (inverse distance and Inverse Square of the distance) are fitted to the data to see which fits better.

Advantage:
The position of the Light Sensor is measured with a Rotary Motion Sensor, eliminating the need to move the sensor at a constant rate or to pause to enter position data on the keyboard.

Experiment Includes:
Basic Optics System
Aperture Bracket
Hooked Mass Set
Thread
Light Sensor
Rotary Motion Sensor
Dynamics Track Mount
Inverse Square Law for Light Experiment Manual
DataStudio File for Inverse Square Law for Light Experiment

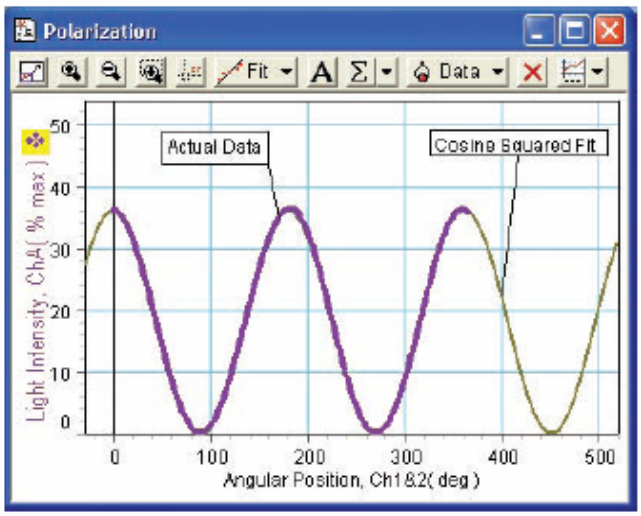
Scientific workshop 500 interface :
Ports: 2 Digital, 3 Analog
Connection: Serial (also USB compatible with USB/Serial Converter)
Data logging: Collect up to 17,000 Analog (force, voltage, etc.) data points or 7,000 Motion Sensor data points
Portable: Built-in battery compartment

POLARISATION DE LA LUMIERE
(Polarisation of Light)



- **Malus' Law of Polarization**

- **Loi De Polarisation de Malus**



In this experiment, Malus' Law of Polarization is verified by showing that the intensity of light passed through 2 polarizers depends on the square of the cosine of the angle between the 2 polarization axes. Laser light (peak wavelength = 650 nm) is passed through 2 polarizers.As the second polarizer (the analyzer) is rotated by hand, the relative light intensity is recorded as a function of the angle between the axes of polarization of the 2 polarizers. The angle is obtained using a Rotary Motion Sensor coupled to the polarizer with a drive belt. The plot of light intensity versus angle can be fitted to the square of the cosine of the angle.

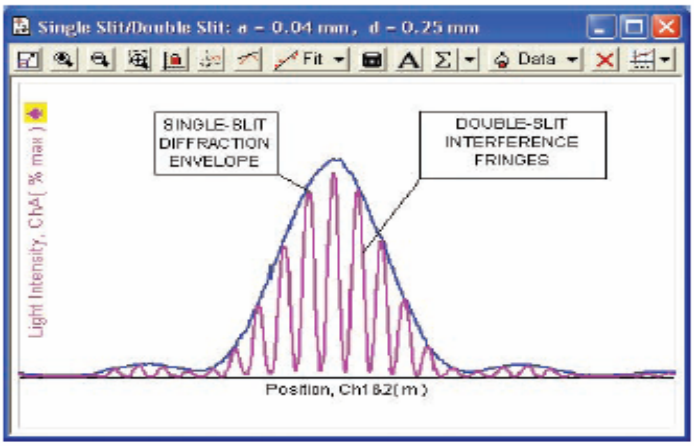
Advantage: Laser light is used in this experiment because its wavelength is more completely extinguished by the crossed polarizers.

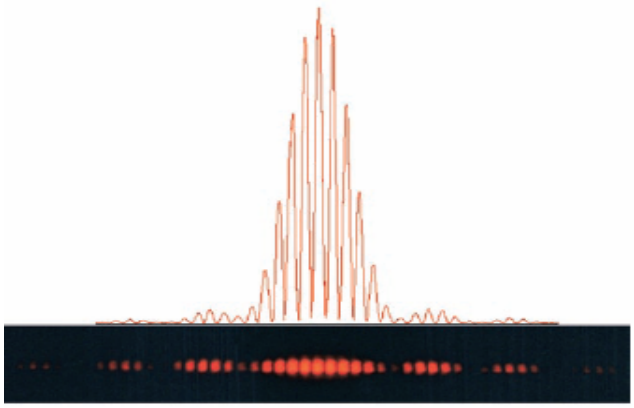
Experiment Includes:

Polarization Analyzer
Basic Optics System
Aperture Bracket
Diode Laser
Light Sensor
Rotary Motion Sensor
Polarization of Light Experiment Manual
DataStudio File for Polarization of Light Experiment

Scientific workshop 500 interface :
Ports: 2 Digital, 3 Analog
Connection: Serial (also USB compatible with USB/Serial Converter)
Data logging: Collect up to 17,000 Analog (force, voltage, etc.) data points or 7,000 Motion Sensor data points
Portable: Built-in battery compartment

INTERFERENCE ET DIFFRACTION DE LA LUMIERE
(Interference and Diffraction of light)


Single Slit/Double Slit: a = 0.04 mm, d = 0.25 mm
Fit
Data
SINGLE-SLIT DIFFRACTION ENVELOPE
DOUBLE-SLIT INTERFERENCE FRINGES
Light Intensity, Ch1[% max]
Position, Ch1 &2 (m)



- **Two-Slit Interference**
- **Single-Slit Diffraction**
- **Multiple-Slit Minor Maxima**
- **Slit Versus Line Diffraction**

- **Interférence Par Deux Fentes**
- **Diffraction Par Une Fente**
- **Les Max Et Min Par Multi-Fente**
- **Fente Et ligne De Diffraction**

Interference and diffraction patterns from laser light passing through various single-slits and multiple-slits are scanned and plotted in real-time. These patterns are then examined for similarities and differences. The distances between the central maximum and the diffraction minima for a single slit are measured by scanning the laser pattern with a Light Sensor and plotting light intensity versus distance. Also, the distances between interference maxima for 2 or more slits are measured. These measurements are compared to theoretical values. Differences and similarities between interference and diffraction patterns are examined.

Advantage:

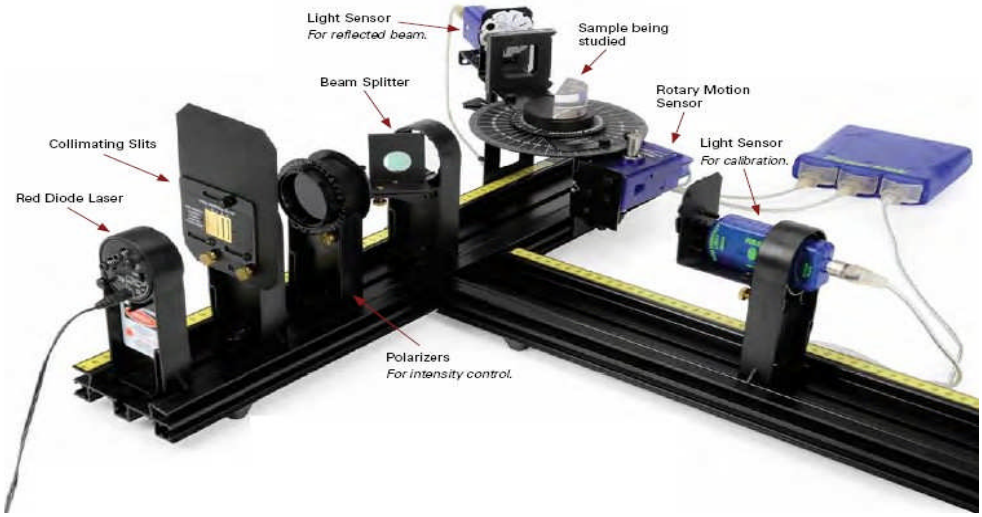
Since the Linear Translator tracks the position of the Light Sensor, it is not necessary to move the Light Sensor at a constant speed. The intensity versus distance graph is plotted in real-time, showing the connection between the intensity pattern and the actual laser pattern.
Adjustment of the slit size on the Light Sensor mask gives the resolution required to see detail in the interference patterns.

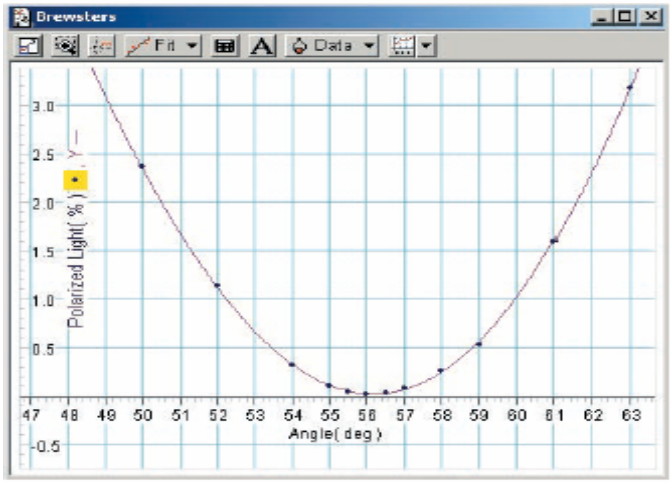
Experiment Includes:

1.2 Optics Track
Diode Laser
Slit Accessories
Light Sensor
Rotary Motion Sensor
Aperture Bracket
Linear Translator
Interference and Diffraction of Light Experiment Manual

Scientific workshop 500 interface :
Ports: 2 Digital, 3 Analog
Connection: Serial (also USB compatible with USB/Serial Converter)
Data logging: Collect up to 17,000 Analog (force, voltage, etc.) data points or 7,000 Motion Sensor data points
Portable: Built-in battery compartment

REFLECTION ET REFRACTON DE LA LUMIERE
ANGLE DE BREWSTER
(Brewster's Angle)





- **Polarization by Reflection**
- **Brewster's Angle**
- **Fresnel's Law of Reflection**
- **Snell's Law**

- **Polarisation Par Réflexion**
- **Angles De Brewster**
- **Loi De Réflexion De Fresnel**
- **Loi De Snell.**

In this experiment, light is partially polarized when reflected off a non conducting surface and Brewster's angle is measured.
Light from a diode laser is reflected off the flat side of an acrylic semi-circular lens. The reflected light passes through a polarizer and is detected by a Light Sensor. The angle of reflection is measured by a Rotary Motion Sensor mounted on the Spectrophotometer table. The intensity of the reflected polarized light versus reflected angle is graphed to determine the angle at which the light intensity is a minimum. This is Brewster's Angle, which is used to calculate the index of refraction of acrylic.

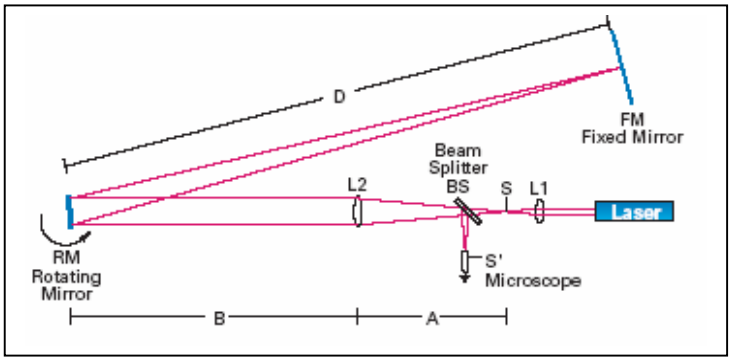
Advantage:

The angle and the relative light intensity are measured by computer, increasing the experiment's precision.

VITESSE DE LA LUMIERE
(Speed of Light)

- **Determine the Speed of Light in Air**
- **Recreate Foucault's Historical Experiment**

- **Détermination De La Vitesse De La Lumière Dans l'Air.**
- **Recrée l'Expérience Historique Du Foucault's**



The Speed of Light Experiment uses laser light and a high-speed rotating mirror to determine this fundamental constant using the Foucault method.
Laser light passes through a series of lenses to produce an image of the light source at a measured position. The light is then directed to a rotating mirror, which reflects the light to a fixed mirror at a known distance from the rotating mirror. The laser light is reflected back through its original path and a new image is formed at a slightly different position. The difference between final/initial positions, angular velocity of the rotating mirror and distance traveled by the light are then used to calculate the speed of light in air.

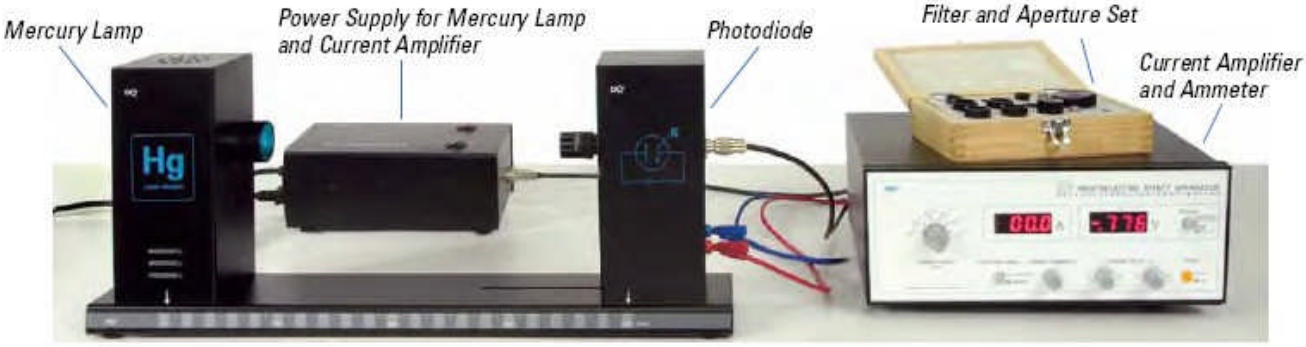
Advantage:

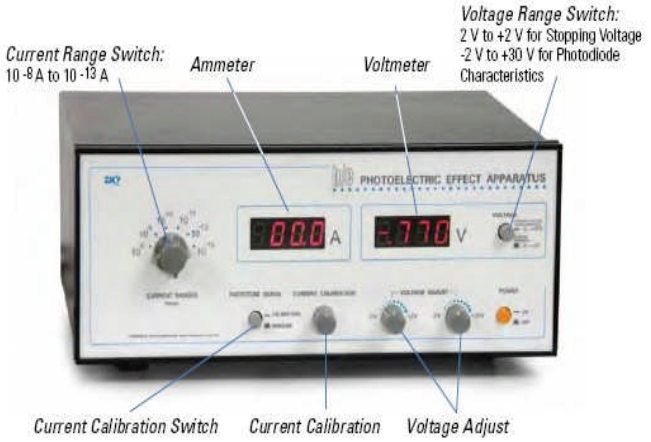
PASCO's Speed of Light Experiment allows students to experimentally measure the speed of light within 5% of the accepted value. In addition, the experiment can be performed on a desktop or in a hallway.

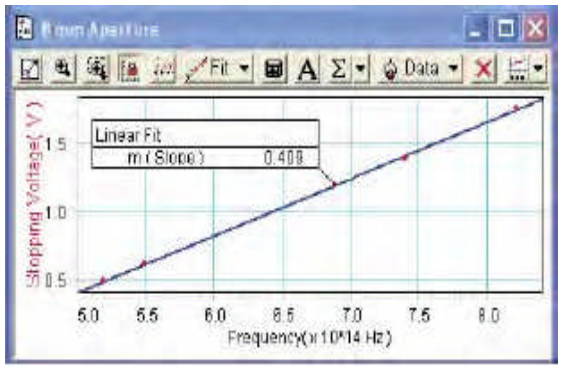
Experiment Includes:

Complete Speed of Light Apparatus
Speed of Light Experiment Manual

L'EFFET PHOTOELECTRIQUE"CONSTANTE DE PLANCK "
(Photoelectric Effect "Planck's constant")




Current Range Switch: 10 -8 A to 10 -13 A
Ammeter
Voltmeter
Voltage Range Switch: 2 V to +2 V for Stopping Voltage -2 V to +30 V for Photodiode Characteristics
PHOTOELECTRIC EFFECT APPARATUS
Current Calibration Switch
Current Calibration
Voltage Adjust



- **Onde de Lumière modelé par rapport au modèle quantum de la lumière.**
- **Relation entre l'énergie, longueur d'onde et la fréquence.**

- **Model D'Onde De Lumière En Fonction Du Modèle De Quantum De Lumière.**
- **La Relation Entre L'Energie, Longueur D'onde Et Fréquence**

The Photoelectric Effect Experiments allows students to directly observe the emission of electrons in a photoelectric tube. The experiment gives students the opportunity to juxtapose the wave model of light with the quantum model of light. Photons from a monochromatic light source strike the cathode in an evacuated tube, causing it to emit electrons. The kinetic energy (Ek) of each electron is equal to the energy deposited by each photon (hv) minus the work function (binding energy) of the cathode (Wo). Some of the emitted electrons strike the anode, causing it to become negatively charged with respect to the cathode. When the anode potential becomes sufficiently large, the photoelectrons have insufficient energy to overcome the potential difference. Therefore, no more electrons reach the anode and the anode potential stabilizes. DataStudio can be used to plot stopping potential vs. frequency of the incident light. The slope of the graph is equal to h/e and the vertical intercept is Wo /e.

Advantage:

PASCO's h/e experiment features a photoelectric head designed to minimize secondary emissions from the anode, which typically interfere with the measurement of Planck's constant. The stopping potential is measured directly, eliminating the need to control extremely small currents during the experiment.

Experiment Includes:

Complete h/e System
Basic Digital Multimeter
Banana Plug Cord - Black (5 pack)
Photoelectric Effect Experiment Manual

L'EFFET PHOTOELECTRIQUE"CONSTANTE DE PLANCK "
(*Experiment Planck Constant)*

- **Dependence of emission process an frequency of radiation.**
- **Critical frequency of metal**
- **The emission of electron is strictly proportional to the intensity of the radiation.**

- **Dépendance Du Process D'émission Et La Fréquence De Radiation**
- **La Fréquence Critique Du Métal**
- **L'Emission De L'électron Est Strictement Proportionnelle à L'intensité De Radiation**

The experimental facts given above are among the strongest evidence that the electromagnetic field is quantified and the field consists of quanta of energy E= hn where n is the frequency of the radiation and h is the Planck's constant. These quanta are called photons.

Further it is assumed that electrons are bound inside the metal surface with an energy ef, where f is called work function. It then follows that if the frequency of the light is such that

hμ > eø

it will be possible to eject photoelectron, while if hn < ef, it would be impossible. In the former case, the excess energy of quantum appears as kinetic energy of the electron, so that

$h\mu = \frac{1}{2}(mn^2 + e\phi)$ ..... (1)

Which is the famous photoelectrons equation formulated by Einstein in 1905.

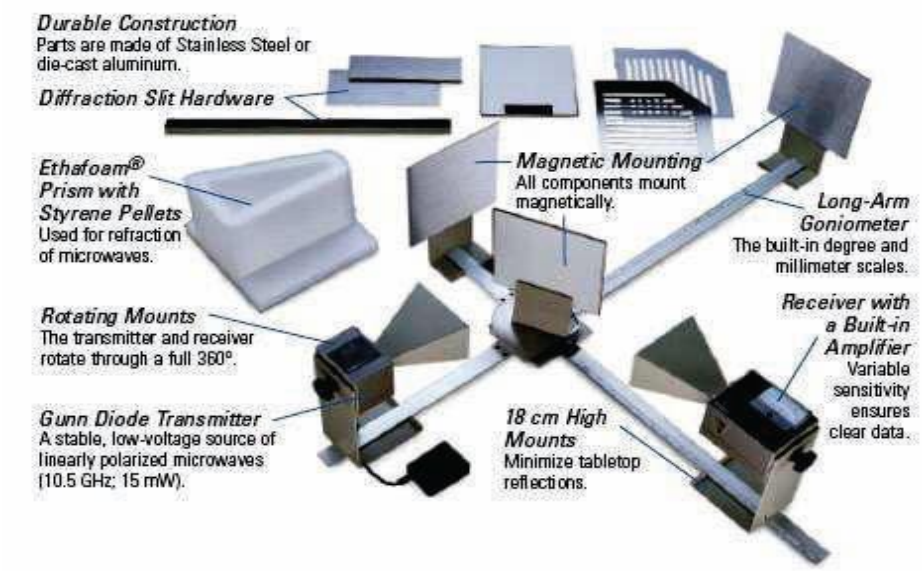
The energy of emitted photoelectrons can be measured by simple retarding potential techniques as is done in this experiment. When a retarding potential V_0 is used to measure kinetic energy of electrons E_e, we have,

$E_e = \frac{1}{2}(mv^2) = eV_0$ or $V_0 = (h/e)(n-\phi)$

So when we plot a graph V_0 as a function of n, the slope of the straight line yields h and the intercept of extrapolated point n=0 can give work function ø.

MICRO-ONDES OPTIQUE

Basic System WA-9314B
Advanced System WA-9316


Durable Construction
Parts are made of Stainless Steel or die-cast aluminum.
Diffraction Slit Hardware
Ethafoam® Prism with Styrene Pellets
Used for refraction of microwaves.
Magnetic Mounting
All components mount magnetically.
Long-Arm Goniometer
The built-in degree and millimeter scales.
Rotating Mounts
The transmitter and receiver rotate through a full 360°.
Receiver with a Built-in Amplifier
Variable sensitivity ensures clear data.
Gunn Diode Transmitter
A stable, low-voltage source of linearly polarized microwaves (10.5 GHz; 15 mW).
18 cm High Mounts
Minimize tabletop reflections.

The Microwave Optics Advantage:

The large 3 cm wavelength makes it easy to understand and visualize Electromagnetic wave interactions. Interference and diffraction slits are several centimeters wide, and polarizers are slotted sheets of Stainless Steel.

Durable Construction:

Parts are made of Stainless Steel or die-cast aluminum.

How It Works:

The heart of the Microwave Optics System is the Gunn Diode Transmitter and receiver. The transmitter is a low voltage source of linearly polarized microwaves(10.5 GHz; 15 mW).
The receiver can detect and measure the intensity of the microwaves at various positions beyond the transmitter. The receiver has a built-in amplifier as well as a variable sensitivity scale, ensuring accurate data for even the lowest intensity measurements.

The WA-9314B Basic Microwave Optics ***System includes:***

- Gunn Diode Transmitter with mounting stand
- Receiver with built-in amplifier and mounting stand
- Goniometer with fixed and rotatable arms and degree scale
- Fixed-arm assembly for interferometer experiments
- Component holders: two standard, one rotating
- Rotating table
- Reflectors: two full reflectors (metal),
- two partial reflectors (wood)
- Polarizers (two)
- Diffraction slit hardware
- Prism (Ethafoam) with styrene pellets
- AC adapter
- Laboratory manual with 12 experiments

The WA-9316 Advanced Microwave Optics ***System includes:***

- **WA-9314B** Basic Microwave Optics System
- **WA-9315** Microwave Accessory Package

Recommended:

The microwave transmitter and receiver assemblies may be purchased separately:

- Microwave Transmitter WA-9801
- Microwave Receiver WA-9800
- Microwave Mounting Stand (two needed) WA-9802

1. **WA-9315** Microwave Accessory Package (included in the WA-9316 Advanced System) Includes a polyethylene panel for measuring Brewster's angle and a simulated crystal for Bragg diffraction experiments. The crystal is a cubic lattice of 100 metal spheres in a 5 x 5 x 4 array, mounted in plastic foam.

2. **WA-9319** Microwave Detector Probe Investigate the nodes and antinodes in standing wave patterns with this microwave probe. It plugs directly into the receiver.

3. **WA-9318** Microwave Transmitter Modulator Modulate a microwave signal to demonstrate Microwave communication. Includes a built-in signal generator (0.4 to 4 kHz) as well as a microphone for voice and music modulation. The signal
can be detected with the microwave receiver, but an oscilloscope is needed to view the signal, or an amplifier and speaker to hear it.

Required for Transmitter Modulator:

- Audio Amplifier
- Open Speaker WA-9900
- 20 MHz Dual Trace Oscilloscope SB-9591A

MODELE FONCTIONNEL DE L'ŒIL

Blind Spot
Simulates retina attachment point
Plastic Eyeball
Holds water to simulate the vitreous humor
Retina
Three positions for near-sighted, far-sighted and normal vision
Crystalline Eye Lens
Interchangeable lenses to focus on near and far objects. Additional slots for pupil and asymmetric lens
Eyeglass Lens Slots
Change to correct vision
Corneal Lens
Fixed glass lens

- **Modèle D'œil Classic à un prix abordable.**
- **modèle de travail de l'oeil humain en 3-dimensions**

Features:

Working Model of the Human Eye:
Two lenses are used to form images on the retina.
Sealed tank holds water to simulate the vitreous humor.

Study the Optics of Normal Vision and Vision Correction:
Use the included plastic lenses to create images for normal vision,far-sightedness, near-sightedness and astigmatism. Additional lenses are placed in front of the eye to correct for vision problems.

Fixed Corneal Lens and Interchangeable Crystalline Lens:
The crystalline lens is surrounded by water (vitreous humor). By changing the crystalline lens, the eye can focus on both near and far objects.

Moveable Retina:
3 positions to demonstrate near-sightedness,far-sightedness and normal vision.

Variable Pupil Size:
Students can observe the change in brightness and clarity of the image as the pupil size is reduced.

Use with Basic Optics:
Size and orientation of the illuminated object can be easily measured.

Specifications:

Focal Lengths in Air of Plastic Lenses: +62 mm (+16d), +120 mm (+8.3d), +400 mm (+2.5d), -1000 mm (-1.0d), -128 mm (-7.8d) cylindrical, +307 mm (+3.26d) cylindrical
Corneal Lens Focal Length in Air: +140 mm (+7.1d)
Dimensions: 15 cm x 17 cm x 10 cm high

Includes:

Molded Plastic Eyeball
Plastic Lenses
(2 sets of 6)
Pupil Aperture
Retina Screen
Experiment Manual

Recommended:

Basic Optics Light Source
Human Eye Replacement Set
(includes lenses, screen and pupil)
Optics Caliper (set of 5)

LASER SOLIDE

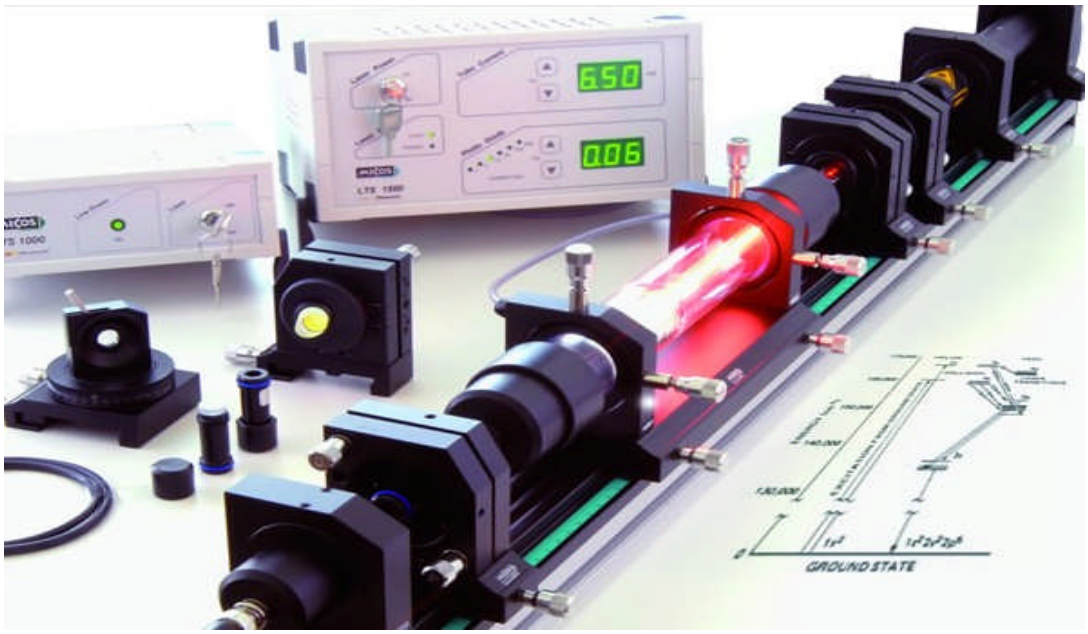
Thèmes des expériences:

Expérience 1: Diode Laser
Expérience 2: Emission et Absorption
Expérience 3: Le Laser Nd:YAG
Expérience 4: Génération de courtes impulsions
Expérience 5: Doublage de la fréquence avec cristal KTP

Corps solides physique laser :

Les montages suivants reproduisent les expériences essentielles sur les principes et les applications d'un laser solide pompé par diode.
De nos jours, **le laser à diodes** (U14031) est surtout utilisé dans trois champs d'application: en technique des communications, en technique de mesure et comme source de lumière de pompage pour le laser solide. Sa longueur d'onde émettrice n'est pas déterminée par deux niveaux d'énergie discrets, mais par la répartition de l'énergie des électrons en bandes d'énergie. Elle dépend ainsi de la température et du courant d'injection. Le rayonnement laser se propage à l'intérieur d'une transition PN et est limité par celle-ci tant au niveau spatial qu'énergétique.
Les différences qui en résultent par rapport aux «lasers classiques à résonateur» feront l'objet de la première expérience.
Au cours de la dernière décennie, les pompes optiques de **laser Nd:YAG** (U14033), à l'aide de diodes laser, se sont établies comme une variante efficace aux systèmes pompés par des lampes. Le cristal Nd:YAG est sans doute le matériel laser le plus important pour le laser solide. Il est utilisé dans la plupart des expériences.
Les expériences permettent d'élaborer les principes du processus laser.
Le choix de la source de pompage adéquate joue un rôle essentiel pour le processus de pompage optique. L'efficacité est directement influencée par le choix des transitions d'absorption et d'émission (U14032).
Des applications importantes sont couvertes par les expériences destinées à générer de courtes impulsions à l'aide d'un déclenchement passif (U14034) et à doubler la fréquence à l'aide de cristaux optiques non-linéaires (U14035).

LASER HE-NE



Educational Objectives

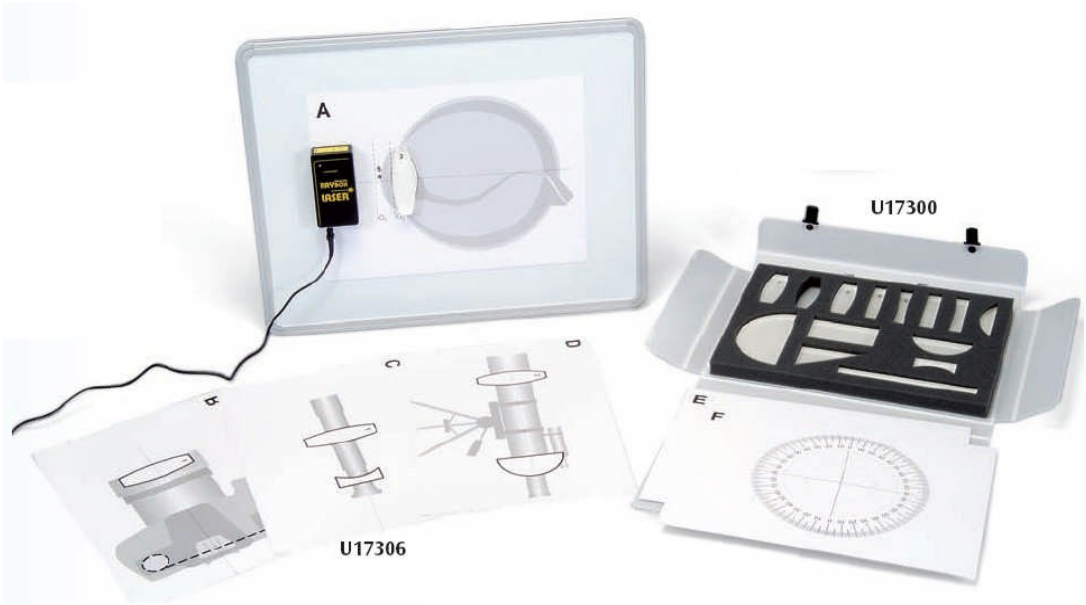
- Energie Levels of HeNe
- Emmision Spectrum of HeNe
- Gain
- Longitudinal & Transversal Modes
- Mode & Line Selection
- Birefringent Filter
- Littrow Prism
- Single Mode Etalon

- **Les niveaux d'Energie HeNe.**
- **Spectre d'émission de HeNe**
- **Gain**
- **Longitudinale et transversale Modes**
- **Sélection de Mode et de Ligne**
- **Filtre biréfringent.**
- **Prism Littrow.**
- **Mode Simple Etalon.**

Includes:

- Flat rail 1000 mm reinforced with scale
- Controller LTS 1500 for HeNe tube and photo diode amplifier
- Laser mirror adjustment holder kinematical on carrier
- Laser mirror adjustment holder kinematical on carrier
- Photo detector in holder on carrier with BNC cable
- Adjustment laser in holders on carriers with power supply
- Birefringent filter in rotating holder on carrier platform with rotating insert
- Littrow prism in adjustable holder on carrier
- Single mode Etalon in adjustable holder on carrier
- Set of 4 laser mirrors

LASER OPTIQUE SUR TABLEAU BLANC



Optique sur tableau blanc :

Thèmes des expériences :

- Lois sur la réflexion
- Lois sur la réfraction
- Réflexion totale
- Angles de déviation minimum dans un prisme
- Détermination de la distance focale de miroirs et de lentilles
- Lois sur les lentilles et aberrations optiques
- Ombrages

Jeu de composants optiques pour un emploi avec la lampe mono faisceau (U40120) ou une lampe multifaisceaux (U40110) sur un tableau magnétique (U10030 ou U10031).
Recouverts d'un film magnétique ou dotés d'un support aimanté, tous les composants peuvent être placés et tournés facilement sur le tableau magnétique. Cet équipement permet de réaliser de nombreuses expériences de démonstration en optique de faisceau sans occultation de la salle. Des annotations écrites à la main sont également possibles.

TELECOMMUNICATION PAR FIBRE OPTIQUES

Thèmes des expériences:

- Fibres optiques et télécommunications par fibres optiques
- Angle d'ouverture et optimisation du couplage dans un câble fibre optique
- Absorption, influence de la longueur de transmission
- Pertes par couplage et découplage
- Diffraction par un réseau optique et multiplexage optique.
- Filtres dichroïques et démultiplexage optique
- Composition spectrale de sources lumineuses
- Décomposition spectrale et recombinaison
- Filtres colorés et filtres d'interférence
- Adaptation et conformation de signaux
- Bande passante et fréquence de seuil
- Calcul de la bande passante théorique
- Diaphonie optique

Système d'expérience complet permettant l'examen quantitatif de la transmission optique d'un signal et du multiplexage et démultiplexage optiques.

Ce système comporte une table magnétique à surface inscriptible et quadrillage pré-tracé, garantissant un montage optique bidimensionnel de haute précision.

Table optique :

- Surface utilisable : 600 x 480 mm²
- Traits du quadrillage : 0°, 45°, 90°, 135°
- Quadrillage, trait de graduation : 5 cm, 1 cm
- Poids : d'environ 6 kg

SPECTRAL TUBE POWER SUPPLY AND MOUNT

- **Spectral Tubes**
- **Argon**
- **Krypton**
- **Carbon Dioxide**
- **Mercury**
- **Helium**
- **Neon**
- **Hydrogen**
- **Water Vapor**

This system is easy to use and inexpensive, with a variety of safety features that make it suitable for beginning labs. Mount any of the 8 different spectral tubes into the power supply and turn it on. The 26 cm long tubes are capillary-thin over the middle 10 cm, providing sharp,bright spectra.

Features:

- Student Safety: The tubes mount
- from the front of the supply and snap into molded sockets that fully enclose the conductive ends.
- The all metal case is electrically grounded.

Spectral Tube Safety:

- A current limiting transformer protects the tubes.
- A protective shield also helps safeguard the tubes while blocking unwanted ambient light for clear viewing.
- Power Requirements: 115/220 VAC, 50/60 Hz.